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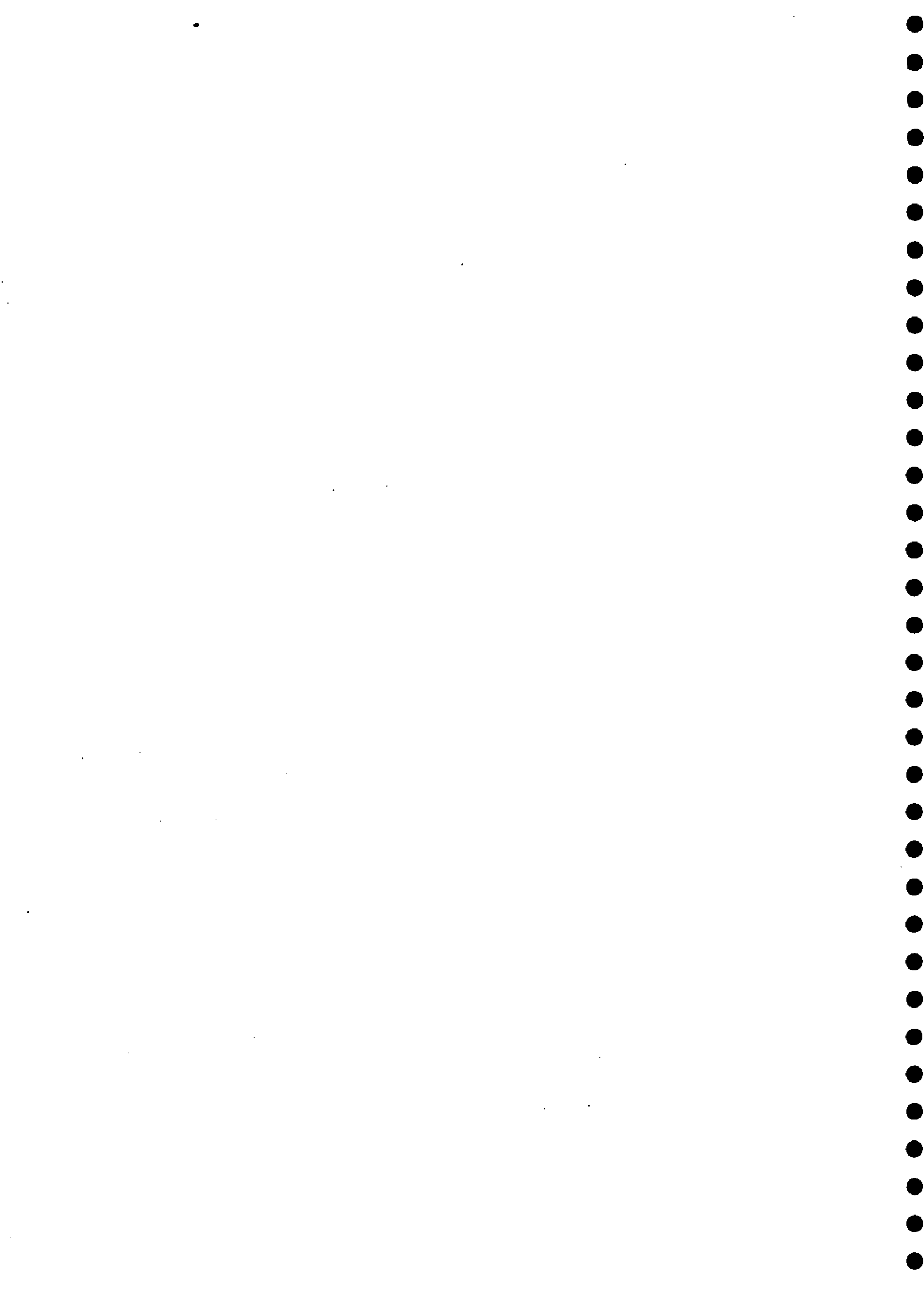
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River Ythan Flow Study

North East River Purification Board

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River Ythan Study

In recent years substantial mats of benthic *Enteromorpha* have developed in the tidal reaches of the River Ythan leading to concern about the quality of the habitat for wading birds. Possible explanations for this include: a changed land-use or land-management strategy, a change in the morphology of the estuary, and a change in the rainfall-runoff regime of the catchment. This note presents a brief investigation of whether this last option is a possible cause.

The flow of the River Ythan has been gauged since 1965 (1966 was the first complete year of data), but the record comprises two parts as the gauging station was moved from Ardlethen to Ellon in 1983. Table 1 gives summary information about the two gauging sites.

Table 1 Flow records on the Ythan

Location	Grid Reference	Period	Type	Area (km ²)	Annual Rainfall (mm)
Ardlethen	NJ924308	1965-1983	Velocity-area	448.1	850 (1965-83)
Ellon	NJ947303	1983-	Velocity-area	523.0	785 (1983-90)

Both gauging stations were operated by the North East River Purification Board (NERPB) who maintain the primary data record. The National Water Archive (NWA) located at the Institute of Hydrology (IH) holds a secondary data record that includes the daily mean flows, monthly maximum and minimum instantaneous flows, and monthly rainfall data. This study only uses the data held by the NWA. Flow data have been combined into a single series by scaling flows from Ardlethen in the ratio of the catchment areas. Rainfall data have been left unscaled as a long-term average annual rainfall is not currently available for the Ellon catchment. Because the additional area of the Ellon catchment is lower lying it is likely that on average its rainfall is 5-10% less than for the Ardlethan; while the figures presented in Table 1 confirm this view, they cannot be used for scaling as they come from different periods.

Figure 1 shows the annual hydrograph of mean daily flows for 1993; it shows a modest response to heavy rainfall and well maintained baseflows. The IH base flow index for the record is slightly over 0.7, indicating that this fraction of the total flow appears at the gauging station as a baseflow component (values of base flow index observed in the UK range from about 0.15 to almost 1.0).

Figure 2 shows the annual rainfall and runoff totals for all years of the record (note that these are from calendar years not water years). Both show considerable variation, with perhaps a slight trend to lower values over time. The strong relationship between rainfall and runoff at this time scale is shown in Figure 3. The regression line shown has an R^2 of

0.83, and corresponds to a model with a gradient not significantly different from 1.0 and an average annual loss (evaporation) of roughly 370mm. At this time-scale it is therefore reasonable to conclude that the variation in flows is not caused by a changed catchment response but by variation in the rainfall.

The annual rainfall totals are plotted again in Figure 4 with a regression line; although the gradient is negative, it is not significantly different from zero at the 95% level. Note also that the apparent slope would have been reduced if the rainfalls from the earlier part of the record had been scaled to adjust for the change in gauging site.

From this examination of the annual data the conclusions are:

- i) variations in flow are caused by variations in rainfall,
- ii) the observed decrease in rainfall volumes is not significant at the 95% level, and
- iii) rainfall (and therefore flow) volumes show a considerable between year variation.

Although it is not possible to identify changes in long term average conditions, it may be possible, and more relevant, to look for modified flood and low flow responses. This has been done by examination of instantaneous flood peaks, and the 95 percentile flow (Q95), which is a low flow measure that indicates the flow that is exceeded 95% of the time. In doing this it should be noted that variations in extreme flows are likely to be more variable than the annual averages as they are caused by shorter time-scale rainfall events that will inevitably contain more variability.

The annual instantaneous maxima are plotted in Figure 5; again these are from calendar years, not water years, but they have been checked for independence. As expected there is considerable variation in these peak flows, and although there is a decreasing trend it is not significant at the 95% level. Figure 6 shows a similar result for the Q95 values; large variability with a decreasing trend, but not significant at the 95% level.

The conclusion is, therefore, that no significant trend in extreme flows can be seen in either of these two data series.

The above brief examination of readily available flow and rainfall data does not indicate a change in the rainfall-runoff response of the catchment. However, this should not be taken as proof that no such change has occurred. More sophisticated techniques looking at the duration and timing of low-flows, or the rainfall-runoff processes during flood events, may reveal that changes have occurred.

However, it is recommended that no further hydrological studies are undertaken until preliminary investigations of land use and management practices have been completed. After this has been done it will be possible to discuss whether hydrological studies alone, or integrated water quality and quantity investigations are required.

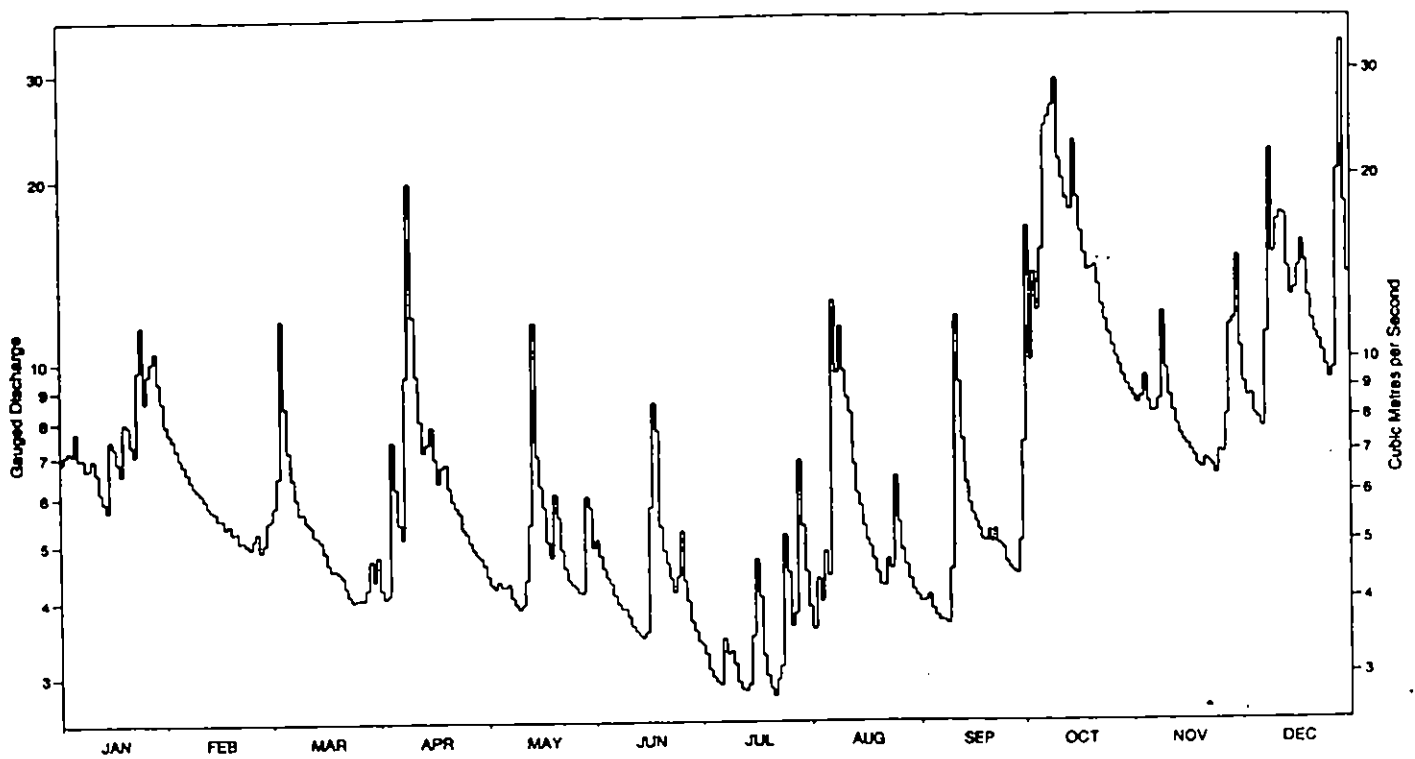


Figure 1 Daily mean flows for 1993.

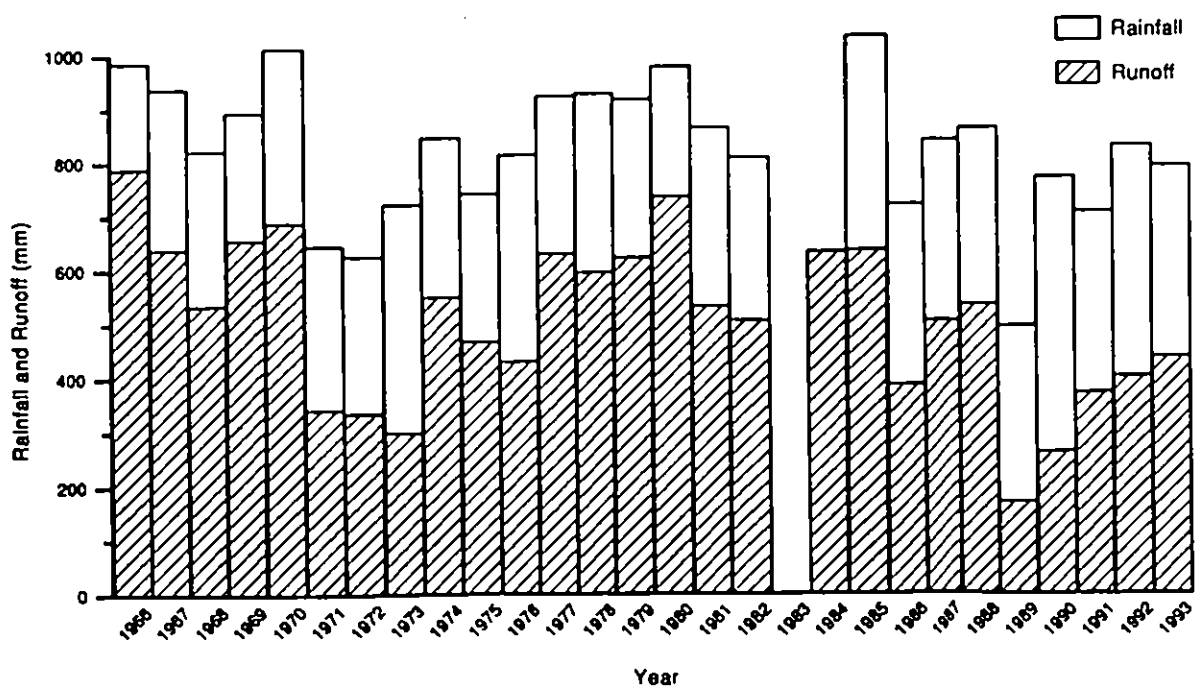


Figure 2 Annual rainfall and runoff.

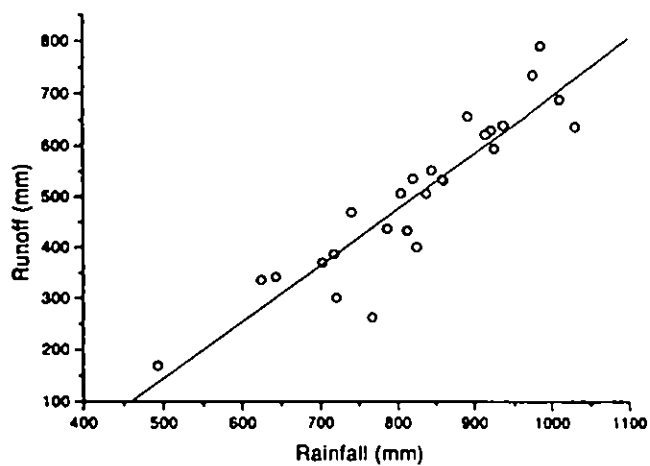


Figure 3 Relationship between annual runoff and rainfall.

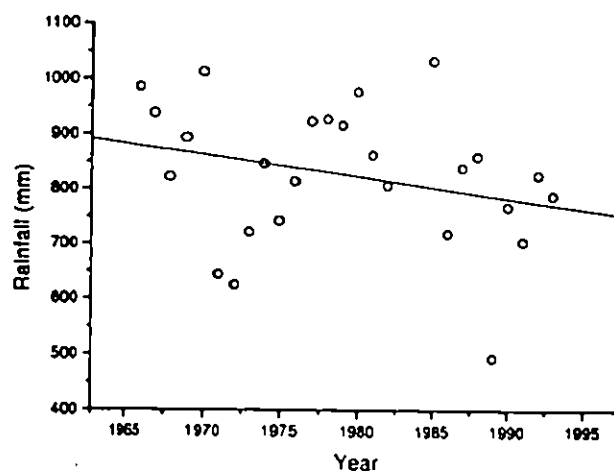


Figure 4 Trend in annual rainfall.

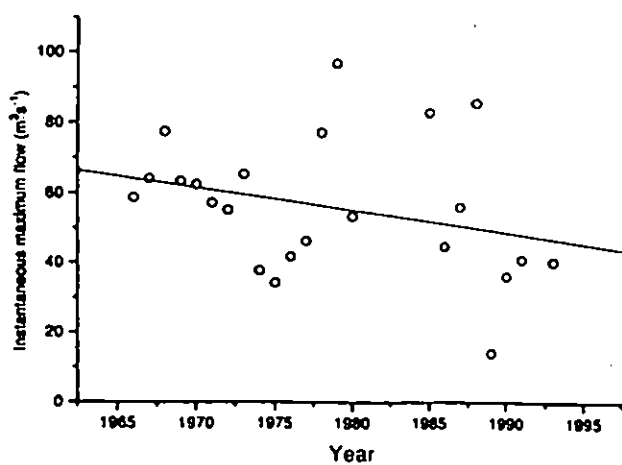


Figure 5 Trend in annual instantaneous maximum flows.

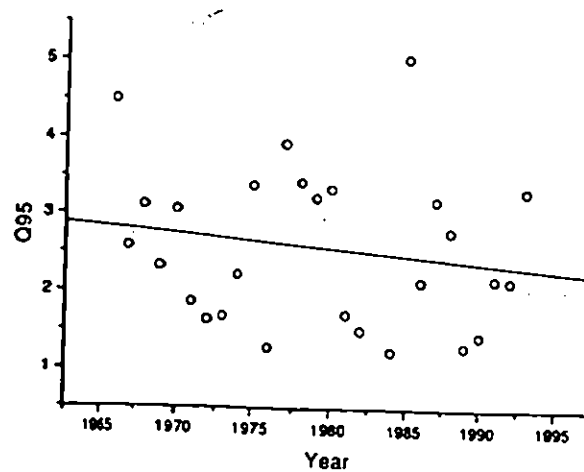


Figure 6 Trend in annual values of the 95 percentile flow.